Forest Health Protection
Pacific Southwest Region

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To: District Ranger, Hat Creek Ranger District, Lassen National Forest

Subject: Insect and Disease Evaluation of the Silvicultural Certification Stand, Unit #321, within the Panner Timber Sale (FHP Report #NE10-08)

At the request of Alissa Tanner, Silviculturist, Hat Creek Ranger District, Danny Cluck, Forest Health Protection (FHP) Entomologist, and Bill Woodruff, FHP Plant Pathologist, conducted a field evaluation of her silvicultural certification stand: Unit #321 in the Panner Timber Sale on July 9, 2010. Ms. Tanner and Matt Staudacher, District Planner/Silviculturist, were present. The objective is to evaluate the current forest health conditions within the stand, discuss what influence these conditions would have on stand management objectives and provide recommendations as appropriate.

Background

The Panner Timber Sale Unit #321 is located on the Lassen National Forest approximately 10 miles southwest of Old Station, CA, and just north of Highway 44 (T32N, R4E, Sections 20 and 29). The elevation ranges from 5300-5600 feet, annual precipitation for the area is approximately 40 inches and the site index is a Dunning 2. This certification stand is a mixed conifer type with white fir (*Abies concolor*) being the dominant species, making up approximately 75% of the stand. Jeffrey pine (*Pinus jeffreyi*), ponderosa pine (*Pinus ponderosa*), lodgepole pine (*Pinus contorta var. murrayana*), sugar pine (*Pinus lambertiana*), and incense cedar (*Calocedrus decurrens*) are all present in lower numbers within the stand (listed by order of abundance). These species are found mostly in the mid and overstory layers as regeneration is limited by dense canopy cover. The stand is currently overstocked with a Stand Density Index (SDI) of 645, which is 118% of the SDI maximum of 548 determined for this site. The stand was also previously logged resulting in the removal of many overstory pines. This harvest activity combined with fire suppression has resulted in the white fir dominated stand conditions. The management objective for this stand is to restore it to a fire-adapted and resilient forest by creating age, structural and species diversity. This stand will be part of a defensive fuel profile zone or DFPZ.

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Observations

Mountain pine beetle (*Dendroctonus ponderosae*) was found attacking and killing larger lodgepole pine (> 8" DBH) growing in predominantly Jeffrey and ponderosa pine areas. There is also a mountain pine beetle outbreak occurring in lodgepole pine stands within a few miles of this unit.

Jeffrey pine beetle (*Dendroctonus jeffreyi*) was observed attacking and killing a couple of larger diameter Jeffrey pine (Figure 1). One- to two-year-old Jeffrey pine beetle-caused mortality was also present near the green infested trees and several large groups of downed Jeffrey pine were found in the same area that were killed by Jeffrey pine beetle during the 1987-1992 drought.

Figure 1. Jeffrey pine larvae, beetles, gallery and pitch tubes on dying Jeffrey pine. (left insert shows pitch tubes from successful attacks; right insert shows larvae and beetles)

A few white fir within the stand were recently attacked and killed by the fir engraver beetle (*Scolytus ventralis*).

White pine blister rust (*Cronartium ribicola*) was observed on an under-story sugar pine girdling the main stem and causing top kill.

True fir dwarf mistletoe (*Arceuthobium abietinum f. sp. concoloris*) appears to be present at very low levels within the stand and branch flagging caused by cytospora canker (*Cytospora abietis*) was observed in a few of these infected trees.

One confirmed Heterobasidion root disease (*Heterobasidion occidentalis*) center was found in an area with older white fir and older cut stumps. Although most of the younger aged white fir areas appeared to be free of root disease, based on crown leader growth.

Regeneration of pine species is lacking within the understory mostly due to shading and competition from true fir.

Western dwarf mistletoe (*Arceuthobium campylopodum*) and elytroderma disease (*Elytroderma deformans*) in Jeffrey and ponderosa pine were also observed in the stand. Neither was present at levels sufficient to cause concern.

Indian paint fungus (*Echinodontium tinctorium*) was observed in several white fir; especially in older trees.

Discussion and Recommendations

Insect and disease caused tree mortality is occurring at a low level within Panner Unit #321, except in the case of a few large diameter Jeffrey and lodgepole pine, despite overstocked stand conditions. During extended dry periods, these overstocked stands would be highly susceptible to bark beetle attacks and subsequent tree mortality as evidenced by the old group kills of Jeffrey pine found in the area.

The thinning alternative being considered for this certification stand will reduce stocking to an average basal area of 160 sq.ft./acre while maintaining average canopy cover at 46%. SDI will be at 280 or 51% of the SDI max. This prescription will meet the requirements of a DFPZ and be consistent with past direction from the Regional Forester to thin to "ensure that density does not exceed an upper limit (for example: 90% of normal basal area, or 60% of maximum stand density index)" and to "design thinnings to ensure that this level will not be reached again for at least 20 years after thinning." (Regional Forester letter, "Conifer Forest Density Management for Multiple Objectives", July 14, 2004). This treatment should effectively reduce tree competition for limited water and nutrients and reduce the risk of insect and disease caused mortality.

When developing the silvicultural prescription for Unit #321, the current low level of dwarf mistletoe, Heterobasidion root disease, Indian paint fungus and elytroderma disease, and the limited bark beetle activity could be addressed by emphasizing infected/infested tree removal but should not keep the District from achieving overall management objectives. The presence white pine blister rust is a special situation and is addressed below.

This prescription will emphasize variability by incorporating unthinned leave groups, pine restoration groups, structural thinning (as opposed to a strict thin from below) and radial thinning around all legacy pines (pines >24" dbh). Drought tolerant species such as Jeffrey, ponderosa and sugar pine will be retained over white fir to help increase their relative numbers within the stand and increase overall species diversity. Preference for removal will be given to diseased trees and trees infested with bark beetles. These methods are consistent with past FHP recommendations for thinning in mixed conifer stands and their use is supported within this unit.

In addition to the above considerations, small group selections could be utilized to remove clumps of trees with root disease or heavy dwarf mistletoe infections; creating openings that can be planted with non-host species such as Jeffrey, ponderosa and rust-resistant sugar pine.

It is recommended that a registered borate compound be applied to all freshly cut pine and white fir stumps >14" dbh. Since it appears that presence of annosus root disease is limited within the stand, treating fir stumps is recommended in order to reduce the chance of creating new infection centers through harvest activity.

If prescribed fire is used as a follow-up treatment to stand thinning, it may result in unacceptable levels of tree mortality; depending on management objectives. This mortality most often occurs as a direct result of cambium or crown injury to individual trees during the fire. Mature ponderosa, Jeffrey and especially sugar pines are susceptible to lethal basal cambium damage during prescribed burns from the heat that develops in the deep duff and litter that accumulates at their bases. These duff mounds typically burn at a slow rate with lethal temperatures, causing severe injury to the cambium which girdles the trees. To protect individual high-value large diameter pine from lethal cambium damage, raking the duff away from the bases of these trees before burning (within 24" of the bole and down to mineral soil) is recommended.

Special consideration needs to be given to sugar pine in the Panner Unit #321. White pine blister rust, a non-native pathogen, has continued to weaken and kill this species over most of its range since its introduction into the Pacific Northwest in 1910. Identification and protection of local rust resistant trees for seed collection, if not already occurring, will aid in the future planting of rust resistant seedlings. Planting openings created by the group selection harvest with rust resistant stock would help insure this species persists in the area.

If you have any questions regarding this report and/or need additional information please contact Danny Cluck at 530-252-6431 or Bill Woodruff at 530-252-6680.

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Insect and Disease Information

Jeffrey Pine Beetle

The Jeffrey pine beetle is the principle bark beetle found attacking Jeffrey pine, which is its only host. It is a native insect occurring from southwestern Oregon southward through California and western Nevada to northern Mexico. The beetle normally breeds in slow-growing, stressed trees. The beetles prefer trees which are large, mature, and occur singly rather than in groups. Yet when an epidemic occurs, the beetle may attack and kill groups of trees greater than 8 inches in diameter, regardless of age or vigor. Often the beetle infests lightning-struck or wind-thrown trees, but does not breed in slash.

Evidence of Attack

Presence of the beetle is usually detected when the foliage changes color. The color change of the foliage is related to the destruction of the cambium layer by the beetle. Generally, the top of the crown begins to fade in a slow sequence, with the needles turning from greenish yellow, to sorrel, and finally to reddish brown. By the time the tree is reddish brown, the beetles have usually abandoned the tree. Another sign of beetle attack is large, reddish pitch tubes projecting from the bark of the infested tree. If examined carefully, pitch tubes can be detected on infested green trees prior to crown fade. Jeffrey pine beetles have a distinctive "J" shape egg gallery pattern on the inner bark. Larval mines extend across the grain and end in open, oval-shaped pupal cells.

Life Stages and Development

The Jeffrey pine beetle is one of the larger pine bark beetles in California. The beetle has a 4 life stages, egg, larva, pupa, and adult. The adults are stout, cylindrical, black, and approximately five-sixteenths of an inch long when mature. The egg is oval and pearly-white. The larva is white, legless, and has a yellow head. The pupa is also white but is slightly smaller than the mature larva. The life cycle is normally completed in one year in the northern part of the range, but in the southern part, two generations per year may occur. The principle period of attack is in June and July, but attacks also are frequent in late September and early October. Similar to other Dendroctonus species, Jeffrey pine beetles use pheromones that attract other beetles to a tree, causing a mass attack that tends to overcome the tree's natural resistance. Blue stain fungi are associated with Jeffrey pine beetle attacks and aid in overcoming the tree’s defenses.

Conditions Affecting Outbreaks

Normally the Jeffrey pine beetle is kept in check by its natural enemies, climatic factors and the resistance of its host. Similar to other Dendroctonus species, the availability of suitable host material is a key factor influencing outbreaks. Healthy trees ordinarily produce abundant amounts of resin, which pitches out attacking beetles. When deprived of moisture, or stressed by other factors such as disease or fire injury, trees cannot produce sufficient resin flow and become susceptible to successful beetle attacks.

Mountain pine beetle

The mountain pine beetle, *Dendroctonus ponderosae*, attacks the bole of ponderosa, lodgepole, sugar and western white pines larger than about 8 inches dbh. Extensive infestations have occurred in mature lodgepole pine forests. Group killing often occurs in mature forests and young overstocked stands of ponderosa, sugar and western white pines.

Evidence of Attack

The first sign of beetle-caused mortality is generally discolored foliage. The mountain pine beetle begins attacking most pine species on the lower 15 feet of the bole. Examination of infested trees usually reveals the presence of pitch tubes. Pitch tubes on successfully infested trees are pink to dark red masses of resin mixed with boring dust. Creamy, white pitch tubes indicate that the tree was able to "pitch out" the beetle and the attack was not successful. In addition to pitch tubes, successfully infested trees will have dry boring dust in the bark crevices and around the base of the tree. Attacking beetles carry the spores of blue-staining fungi which develop and spread throughout the sapwood interrupting the flow of water to the crown. The fungi also reduces the flow of pitch in the tree, thus aiding the beetles in overcoming the tree. The combined action of both beetles and fungi causes the needles to discolor and the tree to die.

Life Stages and Development

The beetle develops through four stages: egg, larva, pupa and adult. The life cycle of the mountain pine beetle varies considerably over its range. One generation per year is typical, with attacks occurring from late June through August. Two generations per year may develop in low elevation sugar pine. Females making their first attacks release aggregating pheromones. These pheromones attract males and other females until a mass attack overcomes the tree. The adults bore long, vertical, egg galleries and lay eggs in niches along the sides of the gallery. The larvae feed in mines perpendicular to the main gallery and construct small pupal cells at the end of these mines where they pupate and transform into adults.

Conditions Affecting Outbreaks

The food supply regulates populations of the beetle. In lodgepole pine, it appears that the beetles select larger trees with thick phloem, however the relationship between beetle populations and phloem thickness in other hosts has not been established. A copious pitch flow from the pines can prevent successful attack. The number of beetles, the characteristics of the tree, and the weather affect the tree's ability to produce enough resin to resist attack. Other factors affecting the abundance of the mountain pine beetle include nematodes, woodpeckers, and predaceous and parasitic insects. As stand susceptibility to the beetle increases because of age, overstocking, diseases or drought, the effectiveness of natural control decreases and pine mortality increases.

Fir Engraver

The fir engraver attacks red and white fir in California. Fir engraver adults and developing broods kill true firs by mining the cambium, phloem, and outer sapwood of the bole, thereby girdling the tree. Trees greater that 4" in diameter are attacked and often killed in a single season. Many trees, weakened through successive attacks, die slowly over a period of years. Others may survive attack as evidenced by old spike-topped fir and trees with individual branch mortality. Although many other species of bark beetles cannot develop successful broods without killing the tree, the fir engraver beetle is able to attack and establish broods when only a portion of the cambium area has been killed.

Evidence of Attack

Fir engravers bore entrance holes along the main stem, usually in areas that are > 4" in diameter. Reddish-brown or white boring dust may be seen along the trunk in bark crevices and in spider webs. Some pitch streamers may be indicative of fir engraver attacks; however, true firs are known to stream pitch for various reasons and there is not clear evidence that pitch streamers indicate subsequent tree mortality or successful attack. Resin canals and pockets in the cortex of the bark are part of the trees defense mechanism. Beetle galleries that contact these structures almost always fail to produce larval galleries as the adults invariably abandon the attack. Pitch tubes, often formed when bark beetles attack pine, are not produced on firs.

Adults excavate horizontal galleries that engrave the sapwood; the larval galleries extend at right angles along the grain. Attacks in the crown may girdle branches resulting in individual branch mortality or "flagging". Numerous attacks over part or the entire bole may kill the upper portion of the crown or the entire tree. A healthy tree can recover if sufficient areas of cambium remain and top-killed trees can produce new leaders. The fir engraver is frequently associated with the roundheaded fir borer and the fir flatheaded borer.

Life Stages and Development

In the summer, adults emerge and attack new host trees. The female enters the tree first followed by the male. Eggs are laid in niches on either side of the gallery. Adult beetles carry the brown staining fungi, *Trichosporium symbioticum*, into the tree that causes a yellowish-brown discoloration around the gallery. The larvae mine straight up and down, perpendicular to the egg gallery. Winter is commonly spent in the larval stage, with pupation occurring in early spring. In most locations, the fir engraver completes its life cycle in 1 year, however at higher elevations 2 years may be required.

Conditions Affecting Outbreaks

Fir engravers bore into any member of the host species on which they land but establish successful galleries only in those that have little or no resistance to attack. Populations of less aggressive species like fir engraver are likely to wax and wane in direct relationship to the stresses of their hosts. Drought conditions often result in widespread fir mortality; however, attempting to determine when outbreaks will occur is difficult. Lowered resistance of trees appears to be a contributing factor. Overstocking and the increased presence of fir on sites that were once occupied by pine species may also contribute to higher than normal levels of fir mortality. Several insect predators, parasites and woodpeckers are commonly associated with the fir engraver and may help in control of populations at endemic levels.

Heterobasidion Root Disease

Heterobasidion spp. is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. Madrone (*Arbutus menziesii*), and a few brush species (*Arctostaphylos spp.* and *Artemisia tridentata*) are occasional hosts. Other hardwood species are apparently not infected. The disease has been reported on all National Forests in California, with incidence particularly high on true fir in northern California, in the eastside pine type forests, and in southern California recreation areas.

Heterobasidion root disease is one of the most important conifer diseases in Region 5. Current estimates are that the disease infests about 2 million acres of commercial forestland in California, resulting in an annual volume loss of 19 million cubic feet. Other potential impacts of the disease include: increased susceptibility of infected trees to attack by bark beetles, mortality of infected trees presently on the site, the loss of the site for future production, and depletion of vegetative cover and increased probability of tree failure and hazard in recreation areas.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar. New infection centers are initiated when airborne spores produced by the conks land and grow on freshly cut stump surfaces. Infection in true fir may also occur through fire and mechanical wounds, or occasionally, through roots of stumps in the absence of surface colonization. From the infected stump surface, the fungus grows down into the roots and then spreads via root-to-root contact to adjacent live trees, resulting in the formation of large disease centers. These infection centers may continue to enlarge until they reach barriers, such as openings in the stand or groups of resistant plants. In pines, the fungus grows through root cambial tissue to the root crown where it girdles and kills the tree. In true fir and other non-resinous species, the fungus sometimes kills trees, but more frequently is confined to the heartwood and inner sapwood of the larger roots. It then eventually extends into the heartwood of the lower trunk and causes chronic decay and growth loss.

Heterobasidion root disease in western North America is caused by two species: *Heterobasidion occidentalis* (also called the 'S' type) and *H. irregularis* (also called the 'P' type). These two species of *Heterobasidion* have major differences in host specificity. *H. irregularis* (‘P’ type) is pathogenic on ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense cedar, western juniper, pinyon, and manzanita. *H. occidentalis* (‘S’ type) is pathogenic on true fir, spruce and giant sequoia. This host specificity is not apparent in isolates from stumps; with *H. occidentalis* being recovered from both pine and true fir stumps. These data suggest that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for many years. Young conifers established near these stumps often die shortly after their roots contact infected roots in the soil.

Dwarf Mistletoe

Dwarf mistletoes (Arceuthobium spp.) are parasitic, flowering plants that can only survive on living conifers in the Pinaceae. They obtain most of their nutrients and all of their water and minerals from their hosts.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and fall from the aerial shoots. The seeds are forcibly discharged. The seed is covered with a sticky substance and adheres to whatever it contacts. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seeds is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occassionaly vectored by birds and animals.

Vertical spread within tree crowns of most dwarf mistletoes is limited to less than one foot per year because of foliage density. Because of the thin crowns of gray pine, however, the vertical rate of spread has been measured as being greater than 2 feet per year. This rate of spread equalled or exceeded the rate of height growth of infected trees.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow-green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings.

White pine blister rust

White pine blister rust is caused by Cronartium ribicola an obligate parasite that attacks 5-needled pines and several species of Ribes spp. The fungus needs the two alternate hosts to survive, spending part of its life on 5-needled pines and the other on Ribes spp. The disease occurs throughout the range of sugar pine to the southern Sierra Nevada, but has not been reported further south. Infection of pines results in cankers on branches and main stems, branch mortality, top kill, and tree mortality.

Spores (aeciospores) produced by the fungus in the spring on pine bole or branch cankers are wind-disseminated to Ribes spp. where they infect the leaves. Spores (urediospores) produced in orange pustules on the underside of the leaves reinfect other Ribes spp. throughout the summer, resulting in an intensification of the rust. A telial spore stage forms on Ribes spp. leaves in the fall. Teliospores germinate in place to produce spores (sporida) which are wind-disseminated to pines and infect current year needles. Following infection, the fungus grows from the needle into the branch and forms a canker. After 2 or 3 years, spores are produced on the cankers and are spread to Ribes spp. to continue the cycle. Although blister rust may spread hundreds of miles from pines to Ribes spp., its spread from Ribes spp. back to pines is usually limited to a few hundred feet.

Branch cankers continue to enlarge as the fungus invades additional tissues and moves toward the bole. Branch cankers within 24 inches of the bole will eventually form bole cankers. Bole cankers result in girdling and death of the tree above the canker. Cankers that have margins more than 24 inches from the main bole are unlikely to reach the bole and only branch flagging will result.